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AN EMPIRICAL TEST OF THE DOMINANT TAX EXTERNALITY IN SWEDEN

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We empirically reexamine the dominance of tax externalities in Sweden for the period of 2000 through 2011. Where hierarchical governments share a mobile tax base, a tax externality can arise not only horizontally across the same level of government but also vertically between different levels of government. A horizontal externality shifts tax rates toward a level that is too low, whereas a vertical externality pushes them toward a level that is too high. The net outcome of these competing effects is theoretically unclear within benevolent federal government systems. Brülhart and Jametti (2006) implemented a pioneering empirical test of the issue using Swiss data. Their empirical setting, however, assumes a single tax instrument, which contradicts the fiscal system in Switzerland. This inconsistency would theoretically distort their estimation. By contrast, our study investigates the pure dominance of tax externality in a sample of Swedish jurisdictions that can tax only personal income. We find a vertical externality to be relatively dominant.

Keywords *Interregional tax competition; Horizontal and vertical tax externalities; Benevolent governmental systems; Personal income taxes; Swedish tax system; Housing market.*

JEL classification: H71; H21; H24; R39.

1. Introduction

In a federation where there is tax-setting autonomy at more than one level of policy decision making, competing jurisdictions often employ tax policy to attract firms and increase resident welfare within their territories. Consequently, tax competition is often included on political and administrative agendas. Numerous relevant studies have been published on this topic, beginning with those by Zodrow and Mieszkowski (1986) and Wilson (1986), with various areas of related research subsequently being developed (Wilson 1999).

The theoretical literature generally shows that a horizontal externality arises if the tax base is mobile across lower-level jurisdictions, whereas a vertical externality manifests itself if different levels of jurisdiction share the same tax base. The presence of a horizontal externality makes taxation too low because each government ignores the outward movement of another government's tax base by lowering its own tax rate. By contrast, the existence of a vertical externality tends to make taxation too high because each government ignores the induced contraction in the tax base of the upper-level government by raising its tax rate (see Keen 1998).

According to Brueckner (2003), some empirical analyses have proved the relevance of this theory, starting with Ladd's (1992) pioneering confirmation of the presence of tax mimicking using US regional data. From the perspective of tax bases, the findings of this field can be categorized as follows: First, in terms of personal income taxes, Goodspeed (2000) provided evidence from 13 Organisation for Economic Co-operation and Development (OECD) countries that higher national income tax rates and lower poverty tax rates lead to lower local income tax rates. Conversely, Esteller-Moré and Solé-Ollé (2001) could not confirm the existence of a significant relationship between state income tax rates, but they did identify the negative impact of the federal rate on the state rate in US income taxation. Subsequent work by Esteller-Moré and Solé-Ollé (2002), however, showed a positive response of income tax rates in Canadian provinces toward those of competing provinces and the federal government.

Second, in terms of business income taxes, Brett and Pinkse (2000), using British Columbian data, found municipal business tax rates to be negatively related to taxes set on the same base by super-municipal jurisdictions, but with no obvious relationship with the tax rates of neighboring municipalities. Additionally, Hayashi and Boadway (2001) concluded that Canadian provincial tax rates also respond negatively to the federal tax rate, with some provinces increasing their tax rates in response to increases in other provincial tax rates. Karkalakos and Kotsogiannis (2007) argued that there exists a positive interaction in tax rates between all provinces and the federal government in Canada. By contrast, Chirinko and Wilson (2011) showed that the slope of the state reaction function for other tax rates is negative but not statistically different from zero in the USA. Carbonnier (2013), however, found that tax competition induces lower corporate taxes and that this bias decreases with respect to the size and number of jurisdictions in French municipalities.

Third, in terms of commodity taxation, most extant studies have investigated only the prospects for vertical strategic interaction. For example, Besley and Rosen (1998) provided some evidence of a significant positive response in state taxes when the US federal government increases cigarette and gasoline taxes. Devereux et al. (2007) likewise confirmed a positive relationship between federal and state excise taxes on cigarettes and gasoline using a panel of US governments. By contrast, Fredriksson and Mamun (2008) revealed that US states may actually reduce their cigarette tax rate in response to an increase in the equivalent federal tax rate. From another perspective, Rizzo (2010), by employing Canadian–US data on cigarette taxes, provided evidence that an increase in the federal tax makes horizontal tax reactions weaker.

Fourth, in terms of property taxation, Wu and Hendrick (2009) showed that municipal governments respond negatively to the county's property tax rate but positively to the school district's property tax rate in the state of Florida in the USA. Lyytikäinen (2012) found no evidence of interdependence in property tax rates among Finnish municipalities. Costa and Carvalho (2013), however, provided strong empirical evidence for the existence of strategic interaction among Portuguese municipalities when setting rates of municipal taxes and for the yardstick hypothesis.

In summary, most past empirical studies have concluded that vertical and horizontal tax externalities are inherent in federal tax structures. Most previous estimations focused directly on the strategic interaction between state and federal governments; however, the "bottom-up" vertical externality must also be considered. A bottom-up vertical externality means that fragmented local governments unduly discount the pressure that national government spending creates by raising their own tax rates insofar as those pressures are shared across all local governments. In other words, the bottom-up vertical externality is likely to leave lower-level government taxes too high. As a result, both types of tax externalities would distort the levels of local government taxation in opposite directions. This will lead us further into a consideration of the dominant tax externality.

As to which of these is the dominant tax externality, Keen and Kotsogiannis (2003, 2004) argued that this depends theoretically on government objectives. If governments are revenue-maximizing leviathans, the tax rates of different hierarchical government levels will be suboptimally high, given the dominance of the vertical externality. Alternatively, if governments are benevolent and aim to maximize the utility of their residents, the outcome is somewhat ambiguous. Therefore, empirical work is required to identify which tax externality dominates in federal systems of benevolent governments.

The findings of the pioneering empirical study by Brülhart and Jametti (2006) indicate the dominance of a vertical tax externality. Their test was applied to a sample of Swiss local jurisdictions. Contrary to their empirical setting, however, cantons and municipalities can set taxes on several tax bases in Switzerland. According to the theoretical literature, jurisdictions would lower taxes on the higher-elastic base and raise taxes on the lower-elastic base to meet a government's revenue needs under multiple tax instruments (Bucovetsky and Wilson 1991; Braid 1996; Keen and Marchand 1997). In other words, irrelevant of a vertical externality, efforts might push tax rates toward a level that is too high. In fact, Brülhart and Jametti (2006) also revealed this point.

In our chosen context of Sweden, the two levels of local government—municipality and county—share the same tax base and can tax personal income only at a proportional rate. In addition, not only does the regional data conveniently contain information about tax base mobility across jurisdictions but also income tax is the most important source of funds for the local and regional public sectors. Our Swedish data set then allows us to examine hypotheses concerning tax externalities properly.

Consequently, our analysis yields three main results using a Swedish data set for the period of 2000 through 2011. Unlike much of the earlier literature, our empirical approach incorporates housing conditions as an obstruction to labor migration and hence changes in the tax base. First, we find that the dominant vertical externality entails suboptimally low municipal tax rates for personal income. Second, its intensity decreases in areas where low housing availability restricts migration. Third, tax rates are strategic complements across municipalities but mostly strategic substitutes between municipalities and counties.

The remainder of this paper is organized as follows: Section 2 begins with a theoretical analysis of tax externalities and then develops empirical models. Section 3 outlines the empirical study and includes the data description, the variable selection, and the empirical results. The concluding discussion is presented in section 4.

2. Theoretical Analysis

This section develops arguments concerning the dominant tax externality and thus serves to bridge the gap between the relevant theoretical and empirical models. As in Brülhart and Jametti (2006), we use a variant of the framework developed by Keen and Kotsogiannis (2002). Our model is, however, interpreted in terms of taxes on personal income.

2.1. The Model

In our model, the economy consists of one upper-level government (hereafter referred to as “county”) and $N \geq 1$ identical lower-level governments (hereafter referred to as “municipalities”). In each municipality j, there is a single firm where a private good is produced using only labor L_j as the input. The production function $F(L_j)$ is concave. Each municipality is populated by a large number of identical residents. We assume that the mass of residents in each municipality is equal to one. The residents have an identical potential labor force (Z^0).

Labor is supplied within the economy or in the rest of the world (ROW). For convenience, the inward labor supply from ROW residents is assumed to be zero because a two-way labor supply unnecessarily complicates the model without changing the qualitative results. When the residents provide labor (Z_j) for the productive sector inside the economy, they earn a unique post-tax wage ω owing to free labor mobility. However, the ROW post-tax wage rate is given by ω^*, which is normalized to zero for simplicity and without loss of generality. If the after-tax wage rate in the economy is lower than in the ROW, ω will take a negative value.

When the price of the private good is normalized to one, the profit maximization condition becomes $F'(L_j) = \omega + \tau_j$. We assume that $(\omega + \tau_j) > 0$ to obtain a positive L_j in equilibrium. According to this condition, we assume the demand for labor in each municipality is as follows:

$$L_j = L(\omega + \tau_j), \text{ with } L'(\omega + \tau_j) = 1/F''(L_j) < 0.$$

Residents equally receive rent generated in municipality j. We define the level of rent as a fixed factor in municipality j using the difference between the production value and labor cost:

$$\pi(\omega + \tau_j) = F[L(\omega + \tau_j)] - (\omega + \tau_j) \cdot L(\omega + \tau_j)\,. \tag{1}$$

The municipality and the county governments levy a source-based tax on each unit of labor within their respective territories. The consolidated tax rate in municipality j is $\tau_j = T + t_j$, where T denotes the unit labor income tax rates of the county and t_j is that of municipality j.

The residents consume not only the private good but also two distinct publicly provided goods, G or g_j. The level of g_j denotes the public goods provided by municipality j, whereas the per municipality level of G expresses the public goods supplied by the county government. Although G and g_j are specific to each municipality, they are referred to as "public goods." The production of public goods exhibits constant returns, and government budget constraints are as follows:

$$g_j = t_j \cdot L(\omega + \tau_j), \tag{2}$$

$$G = \frac{1}{N}\sum_j T \cdot L(\omega + \tau_j)\,. \tag{3}$$

Each jurisdiction's source-based tax per unit of labor finances public good entirely.

The residents derive utility from the ROW labor income ($Z^0 – Z_j$), the domestic labor income (Z_j), rent income (π), and public good (G and g_j). The labor–leisure choice is ignored in this model. We then specify the following aggregate indirect utility function for municipality j:

$$U_j = \left[Z_j^0 - Z_j\right] + u\left[(1+\omega)\cdot Z_j + \pi(\omega+\tau_j)\right] + \Gamma(g_j, G)\,, \tag{4}$$

where both u and Γ are strictly increasing and concave, so $u'' < 0 < u'$ and $\Gamma_{mm} < 0 < \Gamma_m$ ($m = g, G$). The specification of indirect utility implies a degree of "home bias" in the labor allocation because Equation (4) is linear for ROW labor income and concave for domestic labor income. Making use of Equations (1) through(3), we rewrite the aggregate indirect utility function for municipality j as follows:

$$W_j = \left[Z_j^0 - Z_j(\omega,\tau_j)\right] + u\left[(1+\omega)\cdot Z_j(\omega,\tau_j) + \pi(\omega+\tau_j)\right]$$

$$+\Gamma\left[t_j\cdot L(\omega+\tau_j); \frac{1}{N}\sum_j T\cdot L(\omega+\tau_j)\right]. \tag{5}$$

In the economy, the post-tax wage ω is determined by the labor market equilibrium condition:

$$\sum_j Z(\omega,\tau_j) = \sum_j L(\omega+\tau_j)\,. \tag{6}$$

Totally differentiating condition (6) gives the effect of a change in t_j on ω:

$$\frac{\partial\omega}{\partial t_j} = -\frac{Z_\tau - L'}{\sum_j\left(Z_\omega - L'\right)}\,. \tag{7}$$

Given the symmetrical assumption for municipal tax rates, $t_j = t,\ \forall j$, we can rewrite Equation (7) as follows:

$$\frac{\partial\omega}{\partial t} = -\frac{Z_\tau - L'}{Z_\omega - L'} = N\frac{\partial\omega}{\partial t_j} \in [-1, 0)\,.$$

Using this theoretical framework, we now examine the economic condition where the respective tax externalities dominate in equilibrium.

2.2. Derivation of the Dominant Tax Externality Hypothesis

This model assumes that municipal governments are benevolent utility maximizers for residents and that they ignore the influence of their policies on residents in other municipalities. In this case, the tax base share of the county causes vertical externality, and tax base mobility among municipalities results in horizontal externality.

Differentiating W_j with respect to t_j at the symmetric equilibrium gives rise to the following:

$$\hat{W}_j \equiv \left.\frac{\partial W_j}{\partial t_j}\right|_{t_j=t} = -\frac{L}{(1+\omega)} + \Gamma_g\left[L + tL'\left(\frac{\partial \omega}{\partial t_j}+1\right)\right] + \Gamma_G\left[TL'\frac{\partial \omega}{\partial \tau_j} + \frac{T}{N}L'\right] = 0\,. \quad (8)$$

Setting Equation (8) to zero, we implicitly obtain the (symmetric) equilibrium municipal tax rate.

We can also define the aggregate indirect utility function given tax rate symmetry. Differentiating with respect to the symmetric municipal tax rate yields the following:

$$\hat{W} \equiv \frac{\partial W}{\partial t} = -\frac{L}{(1+\omega)} + \Gamma_g\left[L + tL'\cdot\left(\frac{\partial \omega}{\partial t}+1\right)\right] + \Gamma_G\left[TL'\cdot\left(\frac{\partial \omega}{\partial t}+1\right)\right]. \quad (9)$$

By setting Equation (9) to zero, we implicitly find the socially optimal municipal tax rate for a given *T*. If $\hat{W}$ is positive at the Nash equilibrium, a slight increase in all municipal taxes would increase social welfare; conversely, if $\hat{W}$ is negative, municipal tax rates are suboptimally high.

To interpret this argument more easily, we reconsider Equation (9). In addition to subtracting Equation (8) from Equation (9), we introduce notation for the elasticity of utility with respect to the supply of public goods, $\varepsilon_g \equiv (\partial\Gamma/\partial g)\cdot(g/\Gamma)$ and $\varepsilon_G \equiv (\partial\Gamma/\partial G)\cdot(G/\Gamma)$. This manipulation yields the following equation:

$$\Phi \equiv -\frac{L'}{L}\cdot\Gamma\cdot\left(1-\frac{1}{N}\right)\cdot\left[-\varepsilon_g\cdot\frac{\partial\omega}{\partial t}-\varepsilon_G\cdot\left(\frac{\partial\omega}{\partial t}+1\right)\right], \tag{10}$$

where $-\varepsilon_g(\partial\omega/\partial t) > 0$ denotes the horizontal externality and $-\varepsilon_G(\partial\omega/\partial t + 1) < 0$ indicates the vertical externality. Only a vertical externality exists when $(\partial\omega/\partial t) = 0$ in a small open economy such that $\omega = \omega^*$; and only a horizontal externality exists when $(\partial\omega/\partial t) = -1$ in autarky where the total labor supply is completely inelastic (i.e. Z_j is a constant).

Equation (10) will hold true regardless of whether the county and municipality governments set their tax rates simultaneously or sequentially because the county tax rate has no influence on Equation (10) or any of its subsequent derivations. Accordingly, the term in square brackets determines whether the equilibrium municipal taxes are too high or too low, as the first term is clearly positive. All other things being equal, if Φ is positive, a slight increase in all municipal taxes would increase social welfare, and municipal taxes are therefore too low from a social viewpoint. If Φ is negative, a slight increase in all municipal taxes would decrease social welfare, and municipal taxes would be too high from a social viewpoint. We cannot, however, readily observe the crucial variables ε_g, ε_G, or $\partial\omega/\partial t$ in Equation (10) Therefore, the practical empirical analysis in this paper requires a reduced form of the model based on observable variables.

We can compute the effect of a change in N on t_j using Equation (8) as follows:

$$\frac{\partial t_j}{\partial N} = -\frac{\partial\hat{W}_j/\partial N}{\partial\hat{W}_j/\partial t}. \tag{11}$$

The reasoning in Keen and Kotsogiannis (2004) and Brülhart and Jametti (2006) shows that $\partial \hat{W}_j \big/ \partial t$ is negative. Let us then focus on the analysis of $\partial \hat{W}_j \big/ \partial N$. Using Equation (8), we can express the numerator in Equation (11), or $\partial \hat{W}_j \big/ \partial N$, as follows:

$$\frac{\partial \hat{W}_j}{\partial N} = -\frac{1}{N^2}\frac{L'}{L}\Gamma \cdot \left[\varepsilon_g \cdot \frac{\partial \omega}{\partial t} + \varepsilon_G \cdot \left(\frac{\partial \omega}{\partial t} + 1 \right) \right].$$

This equation can be rewritten by employing Equation (10) as follows:

$$\frac{\partial \hat{W}_j}{\partial N} = -\frac{1}{N(N-1)}\Phi . \qquad (12)$$

Given that the effect of a change in N on t_j and Φ (the balance between the types of tax externalities) displays an inverse relationship, we can provide a similar proposition to that of Brülhart and Jametti (2006):

Proposition: *If an increase in the number of municipalities (N) lowers the equilibrium municipal tax rate (t_j), a vertical externality dominates (Φ<0). Conversely, if the relation is reversed, a horizontal externality dominates (Φ>0).*

In line with the proposition, the sign of $\partial t_j / \partial N$ reflects whether the vertical or horizontal tax externality dominates. If municipal tax rates relate positively to the number of municipalities, we can support the dominance of a vertical externality. If not, a horizontal externality dominates.

2.3. From Theory to Empirical Model

According to the proposition, the basic empirical task is to regress t_j on N. Theory provides no guidance as to the appropriate functional form. The natural starting point is a linear additive specification. Before moving to the empirical analysis, however, we address three important estimation issues. These considerations follow Brülhart and Jametti (2006).

First, the aforementioned theoretical discussion comprises a single county. In normal circumstances, the preferred empirical approach would then be a time-series analysis. As the number of municipalities is almost a constant—principally because subcentral jurisdictions amalgamate or separate only rarely in the real economy—we work with a panel of counties comprising varying numbers of municipalities.

Second, the theoretical model assumes symmetric municipalities. In reality, municipalities are typically asymmetric with respect to size, tax rate, and so on. Therefore, we estimate a linear additive specification municipality-by-municipality. From the municipalities' points of view, a high level of N reduces the scale of each municipality in a symmetric county. Incidentally, Brülhart and Jametti (2006) expressed fragmentation as a municipality-specific variable "Smallness" $n_{ij} = 1 - FRAG_{ij}$, where $FRAG_{ij}$ is the population share of municipality j in its corresponding county i. According to their appendix, a marginal increase in the number of municipalities implies that their smallness variables (weakly) increase for all municipalities in the federation. We also employ n_{ij} as a valid proxy for N.

It might seem more intuitive to regress the mean municipal tax rate on a number that reflects the fragmentation of the economy and on national-level averaged controls. Such an empirical approach would be inefficient as it would discard intranational information. However, the basic mechanisms underlying the two tax externalities do not depend on the symmetry assumption. In terms of a vertical tax externality, the crucial variable is n_{ij}, not the fragmentation among the remaining municipalities. The smaller its size relative to the county, the less weight each municipality government places on the county's government, irrespective of the number of other municipalities. In terms of a horizontal tax externality, it has been shown that symmetric tax competition (larger $N \Rightarrow$ lower equilibrium t) carries over to asymmetric settings (larger $n_{ij} \Rightarrow$ lower equilibrium t_j).

Finally, Equation (8) indicates that, ceteris paribus, the municipal tax rate (t_j) is a function of two observable variables, N and T. Moreover, t_j may also be affected by other regional characteristics. The regional characteristics include the average tax rate in adjacent municipalities, the population and number of social welfare recipients, housing conditions, and so on. Consequently, in addition to the smallness variable (n_{ij}), we control for these factors by including specific explanatory variables. Our estimating equation thus becomes the following:

$$t_{ij} = \beta_0 + \beta_1 n_{ij} + \beta_2 T_i + \beta_3 \hat{t}_i + \beta_4 \mathbf{X_{ij}} + \varepsilon_{ij} \qquad i \neq j,$$

where $\hat{t}$ is county-averaged municipal tax rates, $\boldsymbol{X}$ is a row vector of other exogenous controls, and ε_{ij} is a stochastic error term A positive estimated coefficient for n_{ij} indicates the dominance of the vertical tax externality, whereas a negative estimated coefficient for n_{ij} indicates the dominance of the horizontal tax externality. This basic model bears some resemblance to the models put forward in the studies by Besley and Rosen (1998), Goodspeed (2000), Revelli (2001), Brülhart and Jametti (2006), and Devereux et al. (2007).

We estimate six separate models in our analysis. Model 1 explains the variation in the municipal tax rate as a function of the county tax rate, the tax rate in other municipalities, and the relative population size of the municipalities (Smallness). Model 2 includes a vector of exogenous control variables and is therefore comparable to the model in Brülhart and Jametti (2006). Models 3 through 5 are extended model forms where we include additional control variables. Model 6 is a spatial lag model version of model 5. The spatial weight matrix is defined as the inverse square of the distance Other than these differences, model 1 assumes that β_4 is equal to zero, whereas models 2 through 6 assume that β_0 is constant across municipalities.

The models that include a variable indicating the average tax rate for surrounding regions are similar to spatial autoregressive models where the definition of surrounding regions is the spatial weight matrix. We define the spatial weight matrix according to the regions in the same county.

3. Empirical Study

3.1. The Fiscal System in Sweden

Currently, Sweden's subnational governments comprise 290 municipalities spread across 21 counties. County size, in terms of the number of municipalities included, varies from a single municipality to as many as 49, with an average size of about 10. Sweden does not have a formal federal system of government; instead, it has a highly decentralized parliamentary system with a long tradition of local self-government (see Swedish Association of Local Authorities and Regions [SALAR] 2006). Both the Constitution of the Kingdom of Sweden and the Local Government Act of 1992 guarantee municipal and county authorities a considerable degree of political and financial autonomy (see Loughlin and Martin 2004).

The Swedish electorate directly elects both municipality and county councils, and the voter turnout rate is high. The responsibilities of the municipal councils include city planning, planning and financing of the municipal transportation system, primary and secondary education, and selected social welfare functions, including childcare and care of the elderly. Around 40 per cent of municipal expenditures are directed to compulsory schooling and elderly care. In turn, the counties are mainly responsible for health care (accounting for more than 90 per cent of their expenditures), but in some cases, they also handle public transportation and regional development. The various councils can generally organize their activities as they see fit (SALAR 2006).

The municipal and county councils are entitled to levy taxes to finance their activities. Personal income is the revenue tax base for both the municipal and county councils, and they are free to set their own tax rates. The taxation of the same tax base for different hierarchical government levels makes it possible to test the hypothesis of a dominant tax externality—horizontal or vertical. Local funding represents as much as 74 per cent of county council tax revenue and about 69 per cent of municipal tax revenue. That said, even though personal income tax is the tax base for all national, regional, and local levels of government, about 85 per cent of income earners pay only municipal and county income taxes. In addition, there is no minimum level of local taxation, but the central government does decide minimum welfare standards.

A system of interregional fiscal equalization also exists in Sweden, despite a move away from the imposition of uniform national standards (see Loughlin and Martin 2004). The primary objective of interregional fiscal equalization as it stands is summarized as follows:

> [Its purpose is] to put all municipalities and county councils in the country on an equal financing footing to deliver equivalent levels of services to their residents irrespective of the income of local authority residents and other structural factors.
>
> (SALAR 2005)

The main components are cost and income equalization parts. According to Loughlin and Martin (2004), municipalities that raise higher taxes receive smaller grants from the central government.

3.2. Data Description and Variable Selection

We employ cross-sectional time-series data to estimate the aforementioned empirical models. The cross section consists of the 290 municipalities in Sweden and the time series is for the period of 2000 through to 2011. For each municipality we have data on the tax level and its posited determinants. We also have data on the tax level in each of the 21 Swedish counties.

Table 1. Descriptive statistics.

Variable	Mean	SD	Minimum	Maximum
Smallness	0.9330	0.0936	0.3815	0.9968
Municipal tax rate, %	21.3317	1.1505	16.18	23.57
County tax rate, %	10.3784	0.6247	9.22	12.27
Fiscal equalizing	602.3612	2429.148	−4152	13,196
Areal	1402.878	2430.22	8.72	19,371.12
Population	32,858.28	63,790.68	2497	895,086
Population ratio, except 17–64 years	0.4413	0.0262	0.3446	0.5321
Social welfare	33,495.5	106,591.8	255	1,281,985
Primary school	72,281.77	13,637.54	0	128,751
Pre-school	44,664.83	15,205.52	−114	109,891
Housing density	0.4747	0.0463	0.3301	0.7388
House prices, SEK	1146.844	905.5104	198	7061

SD, standard deviation.

The main variable for our discriminating hypothesis is *Smallness* (n_{ij}). As discussed earlier, we calculated the population size of the municipality relative to other municipalities in the same county. This variable is of great importance because if the coefficient is positive, it indicates the presence of a vertical tax externality.

As stipulated by our theoretical model, we have to control for the respective county's tax rates (*County tax rate*). Because the empirical model, unlike the theory, allows for heterogeneity at the municipal level, and because municipal tax rates may be interdependent in an asymmetric fashion, we also ran estimations that included county-averaged municipal tax rates (*Average municipal tax rate in county*) as an additional regressor. These variables do not count the relevant municipality itself.

As previously discussed, Sweden has a system of interregional fiscal equalization to reallocate resources across municipalities, that is, to equalize the tax base. It is important to note that the vertical tax externality might become internalized via the intergovernmental transfer system chosen by the central government (see Aronsson and Wikström 1999, 2001). In other words, the system might lower the municipal tax rate by inducing the correct incentives. Andersson, Aronsson, and Wikström (2004) used Swedish regional data to reject the null hypothesis that a vertical external effect has become internalized. We made sure to control for it, however, by using information about the net fiscal contribution of each municipality (in SEK per capita) (*Fiscal equalizing*).

In addition, we used two dummy variables. The first dummy is for Stockholm county (*Stockholm county*), where the county is responsible for public transportation in addition to health care, unlike other counties The second dummy variable is for the city of Stockholm (*Stockholm city*), where the city must play a role in the capital region.

Although the theory includes no variables, our empirical analysis has a supplementary hypothesis, in which housing conditions can also explain migration. In other words, even if the taxes are low, it can be impossible to move to the region because of the relatively high cost of housing or the lack of suitable rental housing. A larger per capita housing stock makes it easier for labor to move to a region, at least when compared with a region with a smaller housing stock per capita. The same could be said for housing prices. Therefore, a municipality with low housing availability would lower its tax rates so as to attract labor. We used housing density (*Housing density*) and housing prices (*Housing prices*) as proxies for how easy it is for labor to move to a region. Housing density is defined as housing stock per capita. We also have information about each municipality’s size (in square kilometers) (*Areal*).

Moreover, the independent variables in the econometric models comprise information about population (*Population*) and the share of the municipality population aged under 18 and over 64 years, respectively (*Population ratio*). These variables are proxies for the social costs. Brülhart and Jametti (2006) specified population aged under 20 years and over 65 years as proxies for government spending on education, health care, and social security. Our extended model specifies actual expenditures on these items instead of using proxies. To control for the cost side of local government responsibilities, we also have data on the number of social welfare recipients in the municipality (*Social welfare*), the cost for primary schools in the municipality divided by the equivalent cost for Sweden (*Primary school*), and, finally, the cost of childcare (*Pre-school*).

Table 1 shows the average and standard deviations for the variables we are using. As shown, the average income tax rate across Sweden is 31 per cent. The standard deviation is relatively low, with a minimum tax rate of 26 per cent and a maximum tax rate of 34 per cent. We can also see that the tax rate is higher in municipalities than in counties. In addition, the tax rate has increased somewhat over time while the range has decreased slightly.

In stark contrast, the large average value for the smallness variable suggests that many small municipalities exist and few large ones. In addition, there is a sizeable variation in the demographics of the various municipalities. For example, in one municipality, the share of the population aged under 18 and over 64 years is 34 per cent whereas in another it is 53 per cent. The sizes of the municipalities are very different, which the data on population, area, and density confirm.

Thus, there are enormous differences in public expenditure across municipalities. The number of social welfare recipients confirms this pattern in expenditure. This is just one reason why the national government is attempting to harmonize the tax base through the redistribution of municipality tax revenues. In this regard, net gain municipalities receive an additional SEK 4152 per capita, whereas net loss municipalities pay up to SEK 13,196 per capita.

3.3. Empirical Results

As previously discussed, we estimate six different regression models of tax externalities. Model 1 is a feasible generalized least square model that includes only the county tax rate and the average municipal tax rate for the county. Model 2 is similar to those of Brülhart and Jametti (2006) and Devereux et al. (2007), whereas models 3, 4, and 5 are extended by including not only the variables in Brülhart and Jametti's model but also variables representing welfare benefits, income, and the housing market in each municipality. Model 6 is a spatially lagged feasible generalized least square model that includes the same variables as model 5. The findings are presented in Table 2. Almost by definition, the mean municipality tax rate is endogenous. This suggests that we need to apply a two-stage estimation procedure with instrumental variables (see Brueckner 2003, for a discussion). For the instruments, we specify the averages of the control variables.

Table 2. Estimation results for dominant tax externality.

	Model 1		Model 2		Model 3	
	Coeff.	*t*-value	Coeff.	*t*-value	Coeff.	*t*-value
Smallness	0.0519	12.62	0.0213	11.48	−0.0147	−2.19
County tax rate (instrumented)	−1.6063	−31.58	−1.9752	−27.82	0.7219	10.60
Average municipal tax rate in county (instrumented)	0.6614	4.65	0.4144	7.21	0.0887	1.35
Stockholm county	-	-	0.1608	16.17	−0.1658	−16.73
Stockholm city	-	-	−0.0999	−3.47	−0.0659	−2.50
Fiscal equalizing	-	-	-	-	0.0001	9.41
Areal	-	-	-	-	0.0201	46.67
Population	-	-	-	-	−0.0181	−21.43
Population ratio	-	-	-	-	−0.1417	−7.88
Social welfare	-	-	-	-	-	-
Pre-school	-	-	-	-	-	-
Primary school	-	-	-	-	-	-
Housing density	-	-	-	-	-	-
House prices	-	-	-	-	-	-
Spatial lag (instrumented)	-	-	-	-	-	-
Constant	4.7963	0.5448	6.3973	26.86	1.0455	3.72
Wald (p value)	0.0000		0.0000		0.0000	
Kleibergen–Paap (p value)	0.0000		0.0000		0.0000	
Hansen J statistic (p value)	0.0112		0.0000		0.5807	

The dependent variable is the tax rate in the municipality. Feasible generalized least squares (FGLS) estimators with a common first order autoregressive (AR1) coefficient for all panels. Instrument variable estimations are made with average control variables as instruments. The inverse square of the distance s used as a spatial weight matrix.

Table 2. Estimation results for dominant tax externality - Continued -

	Model 4		Model 5		Model 6	
	Coeff.	*t*-value	Coeff.	*t*-value	Coeff.	*t*-value
Smallness	0.0327	3.62	0.0348	3.86	0.0348	3.94
County tax rate (instrumented)	0.7935	10.93	0.6733	9.56	0.6769	9.21
Average municipal tax rate in county (instrumented)	1.7835	10.83	1.9853	10.67	1.9640	10.66
Stockholm county	−0.1160	−16.99	−0.0974	−14.43	−0.0977	−14.17
Stockholm city	−0.0774	−3.67	−0.0809	−4.38	−0.0813	−4.62
Fiscal equalizing	−0.0001	−8.17	−0.0001	−8.35	−0.0001	−8.21
Areal	0.0282	27.23	0.0276	25.75	0.0274	23.62
Population	−0.0238	−18.89	−0.0223	−17.53	−0.0223	−17.32
Population ratio	-	-	-	-	-	-
Social welfare	0.0073	9.44	0.0094	10.74	0.0095	10.97
Pre-school	−0.0169	−10.31	−0.0164	−9.86	−0.0164	−9.83
Primary school	−0.0919	−10.00	−0.0657	−7.99	−0.0649	−7.58
Housing density	-	-	−0.0844	−8.84	−0.0823	−8.44
House prices	-	-	−0.0109	−8.72	−0.0111	−8.65
Spatial lag (instrumented)	-	-	-	-	0.0290	2.32
Constant	−3.0452	−5.65	−3.6994	−6.01	−3.7366	−6.10
Wald (p value)	0.0000		0.0000		0.0000	
Kleibergen–Paap (p value)	0.0000		0.0027		0.0000	
Hansen J statistic(p value)	0.2369		0.0279		0.0824	

The dependent variable is the tax rate in the municipality. Feasible generalized least squares (FGLS) estimators with a common first order autoregressive (AR1) coefficient for all panels. Instrument variable estimations are made with average control variables as instruments. The inverse square of the distance s used as a spatial weight matrix.

First of all, we find a positive and significant estimated coefficient for the smallness parameter. This means, all else being equal, that municipalities with a smaller population share of their county have lower income tax rates. Hence, our result supports the vertical externality hypothesis concerning suboptimally high tax rates. That is, when compared with the optimal level of taxes, taxes are too high. This central result does not change when we include the control variables for government spending.

In fact, Brülhart and Jametti (2006) tested for the issue in their model with a single tax instrument. In Switzerland, however, local governments are allowed to tax on several tax bases. The dependent variables are hereby a municipal revenue-weighted average of nine tax instruments. Following the relevant arguments, the Swiss jurisdictions would lower the tax on corporate income and raise the tax on personal income instead, accounting for well over 70 per cent of municipal tax revenue (see Bucovetsky and Wilson 1991; Braid 1996; Keen and Marchand 1997). In other words, this effect might lead to the dominance of the vertical externality. In fact, their own estimation results on individual tax bases also support it. By contrast, our study shows the pure results of a dominant externality in an empirical setting of jurisdictions which can tax only personal income.

As shown by the estimated coefficient on the county tax rate, municipalities respond inversely when their county government encroaches on their tax base. This finding, however, is valid only for models 1 and 2, not for models 4 through 6. Overall, when compared with the models in the studies by, for example, Brülhart and Jametti (2006) and Devereux et al. (2007), the explanatory power of our models is somewhat lower. The diagnostic tests are satisfactory, however, based on the Anderson and Sargan test statistics.

Furthermore, our results imply that taxes are not strategic complements between municipalities but are mostly strategic substitutes between a county and its constituent municipalities. The results correspond to those of Goodspeed (2000) and Esteller-Moré and

Solé-Ollé (2001). Because the estimated coefficient for the average municipal tax rate is greater than zero and statistically significant, it suggests that cross-border labor migration is high. We find that if the tax rate increases by 1 per cent on average in all municipalities, we expect the tax rate to increase by almost 2 per cent in any given municipality. Put differently, if it were easy for labor to migrate, the coefficient should be close to one, but if the available housing is low, we expect the estimated coefficient to be low or even negative. If it is zero, there is no “spillover” between municipalities.

In addition, the estimated coefficient for the interregional fiscal equalization parameter is also highly significant and positively related to the tax rate in model 3. That is, if a municipality is a net contributor to the equalizing system, the municipal tax rate is higher than what it would otherwise be. However, when we control for the local provision of public goods, the estimated parameter concerning fiscal equalizing is negative (models 4–6), indicating that if one is a net contributor, one can still have a lower municipality tax rate. All coefficients, however, are close to zero. Therefore, interregional fiscal equalization plays but a limited role in the municipal tax rate decision.

In our extended models (models 4–6), municipal tax rates positively and significantly relate to the number of social welfare recipients. However, these models also indicate that municipal tax rates have a significant and negative relationship to the relative costs of primary schools, elderly care, and childcare. In the presence of increasing returns to scale, the the sign of the estimated coefficient for the municipality size parameter is expected to be negative.expected sign of the estimated coefficient for the municipality size parameter should be negative. As anticipated, population has a negative effect on the tax rate. That is, larger municipalities have lower income tax rates, ceteris paribus. Moreover, and according to our expectations, municipal size as measured in square kilometers has a positive impact on the tax rate, indicating that the cost of providing local public goods increases with size.

Finally, let us discuss the robustness of our estimation. Aronsson and Wikström (1999, 2001) posited that if the vertical external effect becomes internalized via the intergovernmental transfer system chosen by the central government, local governments will respond to a unit increase in the county income tax rate by an equal reduction in their own tax rates. However, all estimated coefficients for the interregional fiscal equalization are nearly zero. Consequently, we confirm the robustness of our baseline results.

4. Conclusion

We address empirically the open question of whether horizontal or vertical tax externalities dominate in a decentralized society with a benevolent government. Our study provides three main outcomes for the period of 2000 through to 2011. First, a vertical tax externality dominates. Second, there is a negative relationship between available housing and municipal tax rates. Third, tax rates are strategic complements across municipalities but are mostly strategic substitutes between a municipality and its county.

The first outcome corresponds to the findings of Brülhart and Jametti (2006), concerning the revenue-weighted average of nine municipal taxes in Switzerland. Their estimation, however, might include empirical bias. In fact, local governments can set taxes on several tax bases in Switzerland. Following the relevant theory, the jurisdictions would relatively raise taxes on the lower-elastic bases when the number of regions increased under the fiscal system. Brülhart and Jametti also recognized this bias. By contrast, we investigate the pure dominance of tax externality in a sample of Swedish jurisdictions that can tax only personal income.

The second outcome suggests that a housing shortage could offset the upward pressure on municipal tax rates. Even if the taxes are low, it can be difficult to move to a region where there is little housing available. For example, urban governments might try to attract labor by lowering their tax rates because residents cannot easily migrate to the area.

That is, housing conditions have an important effect on the dominant tax externality, although little attention has been given to the role of the housing market in this field.

The third outcome corresponds to most recent empirical analyses. For example, Goodspeed (2000) and Esteller-Moré and Solé-Ollé (2001) concluded that higher national rates and lower rates of competing jurisdictions lead to lower local rates in the setting of income taxation. Brülhart and Jametti (2006) also derived the same strategic interaction between cantons and municipalities, although they did not directly focus on personal income taxation. Moreover, some empirical studies have also produced similar results in a sample of other tax bases.

Finally, it is possible to draw some policy implications based on our findings. Regarding personal income, a vertical externality dominates in federal systems of benevolent governments. A greater supply of housing would intensify this externality.

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